DOCUMENT RESUME

ED 361 180 SE 053 581

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TITLE The Reality of the Earth Science Classroom.
PUB DATE [93]
NOTE 19p.
PUB TYPE Reports - Research/Technical (143)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS Computer Uses in Education; *Earth Science; Environmental Education; Geology; High Schools; High School Students; Junior High Schools; Junior High School Students; Middle Schools; School Surveys; Science Curriculum; *Science Instruction; *Science Teachers; Secondary School Teachers; Student Characteristics; *Teacher Attitudes; *Teacher Behavior; Teaching Methods
IDENTIFIERS *Kansas; Middle School Students

ABSTRACT

A 1991 survey of Kansas earth science teachers provides findings concerning earth science students, earth science teachers, and some current practices in earth science instruction. Generally students take earth science in seventh, eighth, or ninth grade. About two-thirds of the students taking earth science do so at the ninth grade level. The course is the designated or required course at that grade level, or is elected at the high school level to meet a graduation requirement in the sciences. It is presumed that the majority taking earth science at the high school level are not science-oriented students. The typical teacher of earth science has 12 or more years of teaching experience, and possesses the bachelors degree only. Nearly three-fourths have two or more different class preparations. Preferences for professional development include subject matter courses rather than education courses, and summer-based course offerings rather than other alternatives. More than half of the respondents have had a course or workshop opportunity in the past year which they believe enhanced their competence or confidence with their teaching. The most frequent mode of instruction involves reading one or more texts with the occasional use of laboratory exercises as verification activities. About seventy percent of teacher respondents reported access to computers; report writing and data management are the most frequent uses of computers. Evidence exists that earth science teachers include "environment" topics in the earth science curriculum. Teachers reported higher confidence teaching conceptual topics rather than those which involved the recognition of salient characteristics for the identification of specific rocks and minerals. (Author)

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THE REALITY OF THE EARTH SCIENCE CLASSROOM

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A 1991 survey of Kansas earth science teachers provides findings concerning earth science students, earth science teachers, and some current practices in earth science instruction.

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Evidence exists that earth science teachers include "environmental" topics in the earth science curriculum. Teachers reported higher confidence teaching conceptual topics (e. g., seasons, geomorphic processes, particulate nature of matter, rock cycle) rather than those which involved the recognition of salient characteristics for the identification of specific rocks and minerals.

Key words: Earth science; earth science - teacher education; earth science teaching; education - science; education - secondary; geology teaching

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THE REALITY OF THE EARTH SCIENCE CLASSROOM

Introduction

Conventional wisdom holds that earth science may be taught at the middle or junior high school level as a standard or required course offering, or at the secondary (high) school level to serve two different functions. Earth science at the high school level sometimes serves as a terminal science course to meet minimum science or laboratory graduation requirements or it may serve as a prerequisite to other high school science courses. Whether the function of the course is introductory or terminal, earth science has an important role in pre-college science education. It shapes students' attitudes toward science, provides science content knowledge, develops science reasoning skills, and increases students' knowledge of the role of science in society.

In an attempt to determine the current status of earth science education in Kansas, the Emporia State University Science and Mathematics Education Center (SMEC) coordinated a survey of Kansas science teachers in the spring of 1991. Survey data provide educators and policy makers with an empirical foundation for making recommendations and setting strategies to improve earth science education. Data from this survey, as well as from other published earth science education reports, will be utilized to describe earth science teachers, earth science students, and the process of earth science teaching.

Kansas Surveys

A number of different surveys have been conducted regarding science education practices in Kansas, particularly from the perspective of the biological sciences (Breukelman and Andrews, 1953; Breukelman and Andrews, 1956; Baker and Brooks, 1957; and, Breukelman and Frazier, 1961). Two additional state-wide surveys were conducted in 1983 and 1987 (Davis 1983 and 1987); however, the data were collated, analyzed for internal purposes, but were not published. Enochs, Oliver, and Wright (1987) also surveyed Kansas secondary science teachers focusing on trends in methodology. There have been no state-wide science surveys published in the last four years, nor have there been any previous surveys which focused solely on the earth sciences.

In the fall of 1990 plans and activities began for developing a science survey to be mailed to all Kansas junior/middle and secondary science teachers in April 1991. Careful consideration was given to question type and style. The final instrument was reviewed by several science educators to ensure face validity. The surveys requested information from Kansas teachers of biology, chemistry, earth science, general science, physical science, and physics. Requested data included such information as school demographics, classroom practices, teacher background and characteristics, and participation with continuing education. There were 957 science surveys mailed, and 375 were returned (return rate of 39 percent). Of those returned, 173 respondents indicated that they taught earth science. Data provided by the Kansas Department of Education for the 1990-1991 academic year suggests that there

were 103 certified earth science teachers in Kansas schools (Kansas State Board of Education, 1991). We assume that a number of these "earth science" teachers reporting represent teachers of earth science at the junior high/middle school level where a specific earth science endorsement (teaching credential or certification) may not be required. These additional respondents may also be teaching a general or physical science course with an appreciable amount of earth science and consider themselves to be "earth science" teachers. Our assumption is supported by the fact that about 20 percent of the respondents taught at schools possessing a grade 6-8 structure, nearly 19 percent taught at schools with a 7-8 structure, and about 18 percent taught at schools with a 9-12 structure. The remainder of the respondents taught at various other combinations of kindergarten through grade twelve school configurations.

Earth Science Students

Of the 375 total respondents, 133 (35.5%) reported that earth science was required at some level. Among the physical sciences, only physical science, as a course, (36.0 percent) was required more frequently. We suspect that the perception of a "requirement" is misleading. Perhaps these are respondents from the pre-high school level reporting that all students enroll in a science, and that earth science is the content focus. Nearly sixty-eight percent of the respondents reported that students take earth science as ninth graders. This contrasts with an Iowa study (Hoff, et al., 1986) which reported percentages of about 45 percent and 30 percent for the eighth and ninth

grades, respectively. Thus, the "typical" pre-college earth science student is likely a middle/junior high school student.

Earth Science Teachers

More than half (51.5 percent) of the earth science teacher respondents have more than 12 years of teaching experience. The bachelor's degree is the highest degree possessed by 59.6 percent of the respondents, while the master's degree is the highest degree indicated by 38.6 percent. None reported earning a doctorate, but 1.8 percent hold a specialist degree in education. Unfortunately, it is not possible from the survey to discern details regarding the respondents' specific subject matter background in the earth sciences. Nearly 29 percent (50 of 173) of the respondents identified themselves as being fully certified to teach earth science. We suspect that there is a difference between the earth science course backgrounds of more experienced teachers and those of more recently certified earth science graduates who have had to meet more stringent certification requirements. Earth science teachers are generalists and teach more than earth science. Those surveyed averaged 2.4 class preparations per day with about 72 percent having two or more preparations per day.

When updating their professional knowledge, the earth science teachers surveyed expressed a preference for science subject matter courses rather than education courses by a margin of almost 4 to 1 (79.8 to 19.1 percent). The majority of respondents (68.8 percent) favor courses offered in the summer more so than courses offered on weekends, as correspondence, television-based, or as late afternoon or evening courses. More than half of

the respondents had taken a science course or participated in a science inservice workshop in the last year which they believed had improved their competence and confidence in teaching.

Earth Science Teaching

Tables 1 and 2 illustrate the reported approaches to teaching earth science, and the way most "experiments" are conducted in the earth science classes.

**********INSERT TABLE 1**********

**********INSERT TABLE 2**********

The earth science teachers cited lack of money to purchase equipment and supplies and lack of space as the principal impediments to conducting more true laboratory experiments. Thus, based on Tables 1 and 2, the opportunity for extensive hands-on encounters with earth science is limited. Further, most experiments appear to be "verification" rather than inquiry-based activities.

Computers are one form of technology that over 71 percent of the respondents had available for students to use. Apple IIc/IIe (59 percent), Macintosh (16 percent), and IBM PC/PS/XT/AT (15 percent) are the types of computers most frequently available for use. Table 3 indicates the uses for computers by Kansas earth science teachers.

**********INSERT TABLE 3**********

Other response items suggest that nearly half of the earth science teachers view computers as just another tool to be used in the earth science classroom;

less than 5 percent perceive the use of computers as a serious threat to "real labs, field trips, etc."

Field trips are utilized by more than 93 percent of the earth science teachers surveyed. However, more than half of the respondents believe additional field trips are necessary and desirable. Common reasons cited for the limited number and length of field trips include administrative red tape and insurance concerns, costs, and the use of media that supplants the need for field trips. Thus, the 93 percent reported does not imply that field trips are meeting their full educational potential as instructional strategies.

Many environmental education topics are addressed by the earth science teachers. Table 4 lists environmental topics and the percentage of respondents that spend one or more class periods teaching about that environmental topic.

**********INSERT TABLE 4**********

Earth science teachers were asked about their level of confidence with teaching common earth science topics. The topics were listed and teachers indicated their level of confidence; "5" represented highly confident, "4" above average confidence, "3" average confidence, "2" below average confidence, and "1" represented total lack of confidence. Table 5 lists earth science topics and the percentages of teachers reporting below average confidence or a total lack of confidence in teaching the selected earth science topics.

**********INSERT TABLE 5**********

Table 6 lists the five most frequently used earth science textbooks reported by earth science teachers. The five most frequently used texts

**********INSERT TABLE 6**********

devote the greatest number of chapters to geology topics (nearly 50 percent). Most chapters are devoted to physical geology with generally fewer chapters allocated to astronomy and meteorology. Oceanography topics are treated in relatively few chapters. The balance of the chapters address multidisciplinary areas, such as human impact on the environment and resource requirements, and nearly all the texts have an introductory chapter.

What is Earth Science Teaching Really Like?

It is very difficult to communicate to a non-teacher what teaching at the middle school or high school level is really like. Taken from student teachers, beginning teachers, and experienced teachers, the best answer given to "What is earth science teaching really like?" was: "You don't know what teaching is really like until you teach!" And, "real" teaching involves teaching for an extended period of time, not just an occasional appearance as a guest speaker.

Geoscientists have a passion, if not for the breath of the geosciences, at least for their area of specialty. In addition, geoscientists generally have an appreciation for the subdisciplines of geoscience outside their specialty areas. Aldridge and Johnston (1984) reported that for every 1000 high school freshmen, less than 4 percent graduate from a college or university with a bachelor's degree in a science related field, let alone one of the earth sciences. It is important for us who have made a commitment to the sciences and/or science education to accept the fact that most students have an initial lack of interest in earth science.

Earth science faces challenges, yet there is reason for optimism. Recent initiatives and interest in earth science education by professional organization

such as the AGI, GSA, and NAGT are moving earth science education in a positive direction. Fortunately for most earth science teachers, the situation is not as grave as one described by Flansburg (1992) in which he quoted a teacher as characterizing students as cheaters, apathetic, disrespectful, self-centered, and more interested in jobs, cars, and the opposite sex than learning.

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Approach to science	Percent of respondents reporting this use
Do occasional experiments and read from text(s)	60.7
Experiment regularly with supplemental reading	38.7
Read from one science text	21.5
Read from multiple textbooks	12.7

Table 1. Approaches to teaching earth science.

Approach to conducting experiments	Percent of respondents reporting this methodology
Students conduct experiments that illustrate a concept or process that has already been presented	64.2
Students conduct experiments as an introduction and/or predominant part of most units	27.7
As teacher demonstrations	23.7
Don't perform experiments	12.7

Table 2. Approaches to conducting experiments.

Type of computer use	Percent of respondents reporting this use
Word-processing for report writing	34.7
Data management	32.4
Simulations	26.6
Independent advanced projects	24.9
Individual remediation	20.2
Drill and practice	16.8
Interface with experiments	10.4
On-line access to outside resources	5.2

Table 3. Percentage of types of computer use by Kansas earth science teachers.

Environmental topic	Percent of respondents that spend one or more class periods with the topic
Water pollution	78.6
Acid rain	77.5
Alternate energy sources	74.0
Soil erosion	72.8
Air pollution	72.3
Conservation ethic	62.4
Solid waste recycling	60.7
Ozone/global warming	56.3
Nuclear waste	50.9
Sewage disposal	38.2

Table 4. Percentage of earth science teachers that spend one or more days teaching specific environmental topics.

Earth science topic	Percent of respondents expressing below average confidence
Rock identification	27.3
Mineral identification	26.3
Fossils	23.3
Geologic history	19.0
Evolution	18.5
Folded and faulted mountain ranges	12.6
Sun as a star in our galaxy	12.1
Rock cycle	11.5
Humidity and clouds	10.3
Sea floor spreading/plate tectonics	9.2
Earth's interior	8.6
Pollution	8.5
Atoms as the Earth's building units	7.0
Earth's shape and gravity	6.9
Geomorphic processes	5.8
Seasons	2.9

Table 5. Percentage of earth science teachers reporting below average confidence or a total lack of confidence in teaching commonly taught earth science topics.

Textbook Title	Publisher	Frequency
Earth Science	Prentice Hall	20
Focus on Earth Science	Merrill	19
Modern Earth Science	Holt, Rinehart, and Winston	19
Earth Science	Scott Foresman	12
Earth Sciecne	Silver, Burdett, and Ginn	12

Table 6. The five most frequently used earth science textbooks.